



Hole Drift & Microcrystalline Silicon Solar Cells

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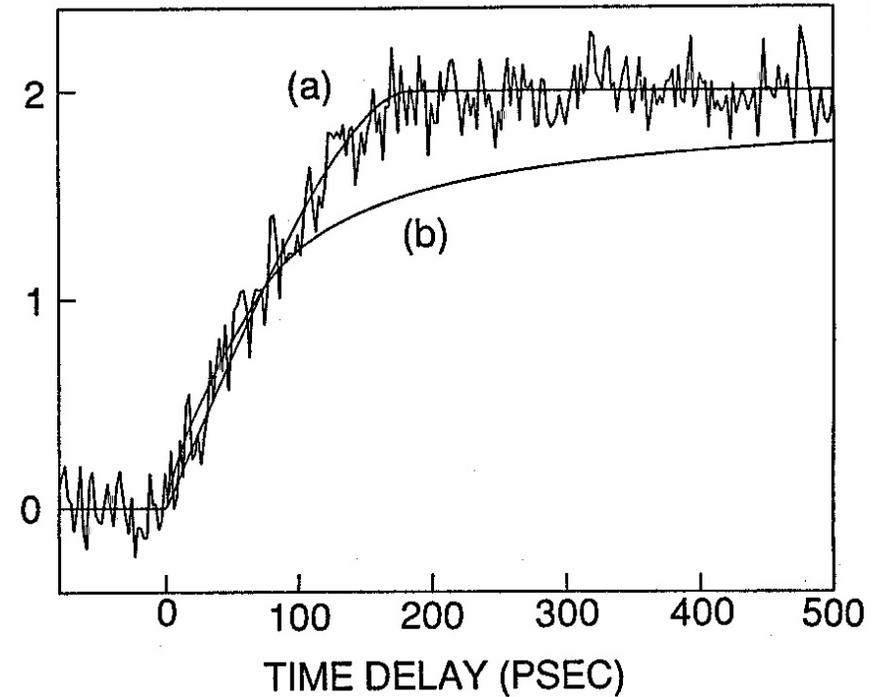
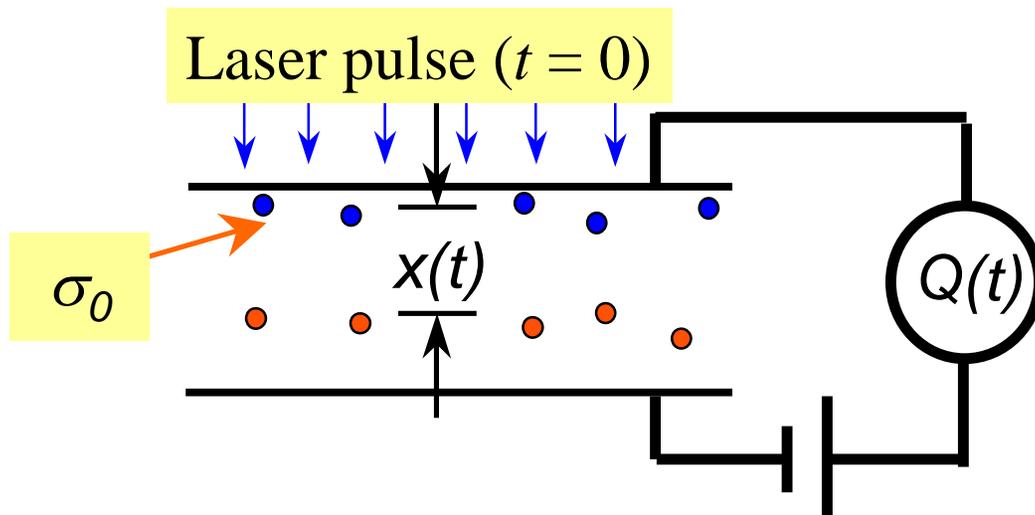


Summary

- 2 classes of ordinary solar cells
 - Low-mobility cells. Output power dominated by slow-carrier drift vs. time.
 - High-mobility cells. Output power dominated ambipolar diffusion.
- Amorphous silicon cells: low-mobility type
- Microcrystalline cells: near crossover between the low & high mobility cells.



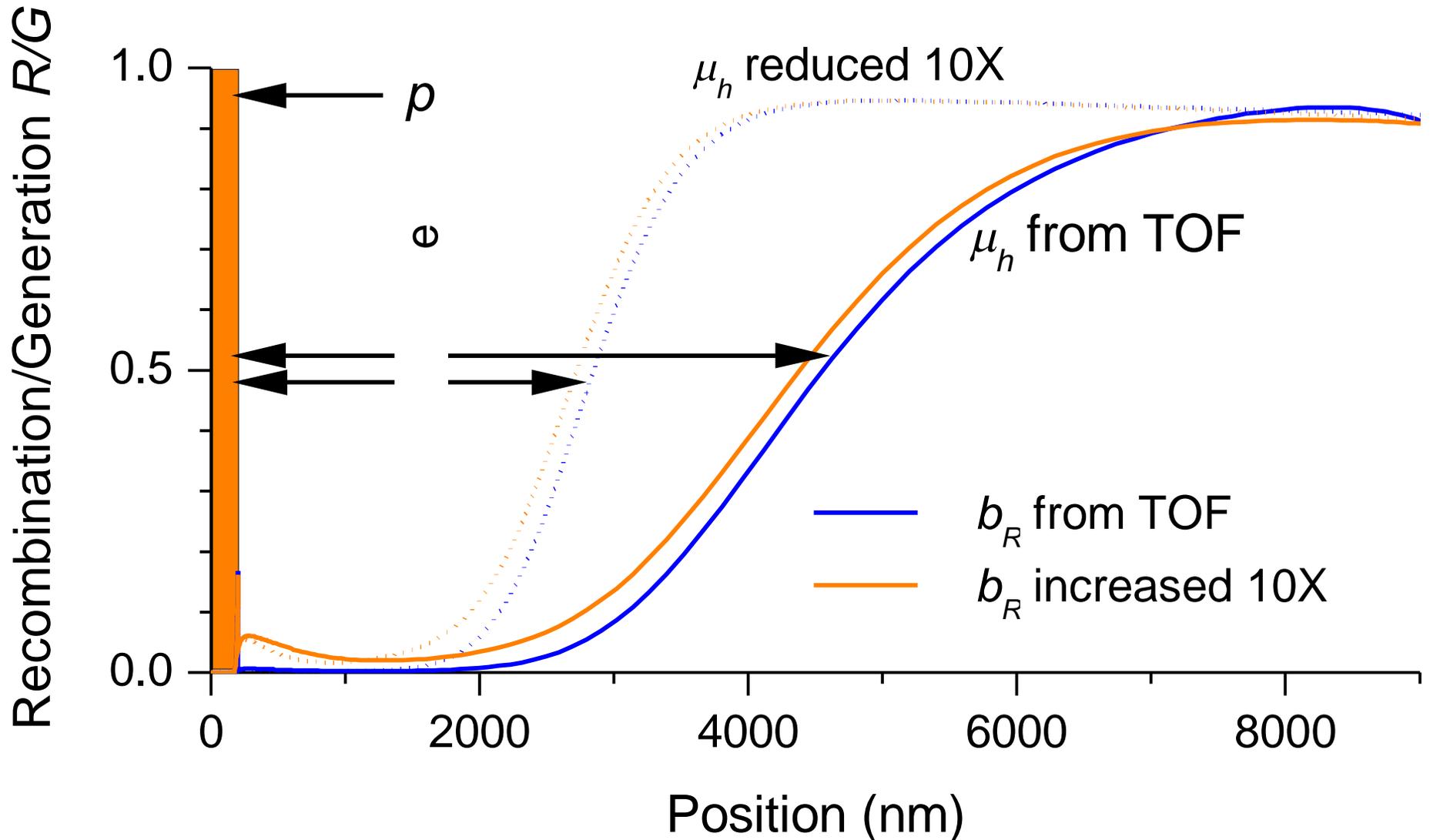
Photocarrier Drift Experiments



- $Q(t) \cdot V = (\sigma_0 A) \cdot x(t) \cdot (V/d)$
- $\mu_D = x(t)/(Ft)$

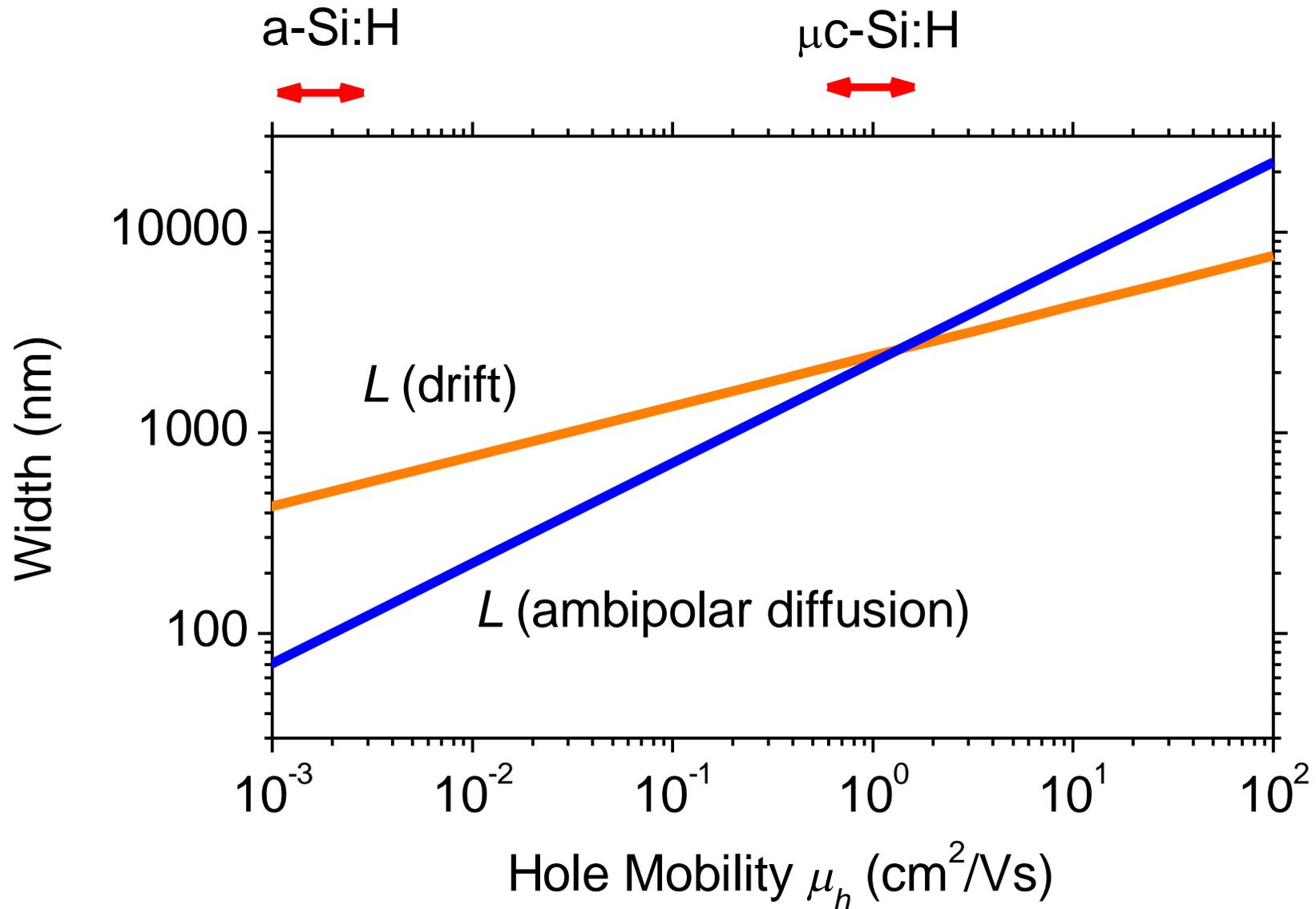


AMPS Calculations Show Why The Hole Drift Mobility Can Be So Important



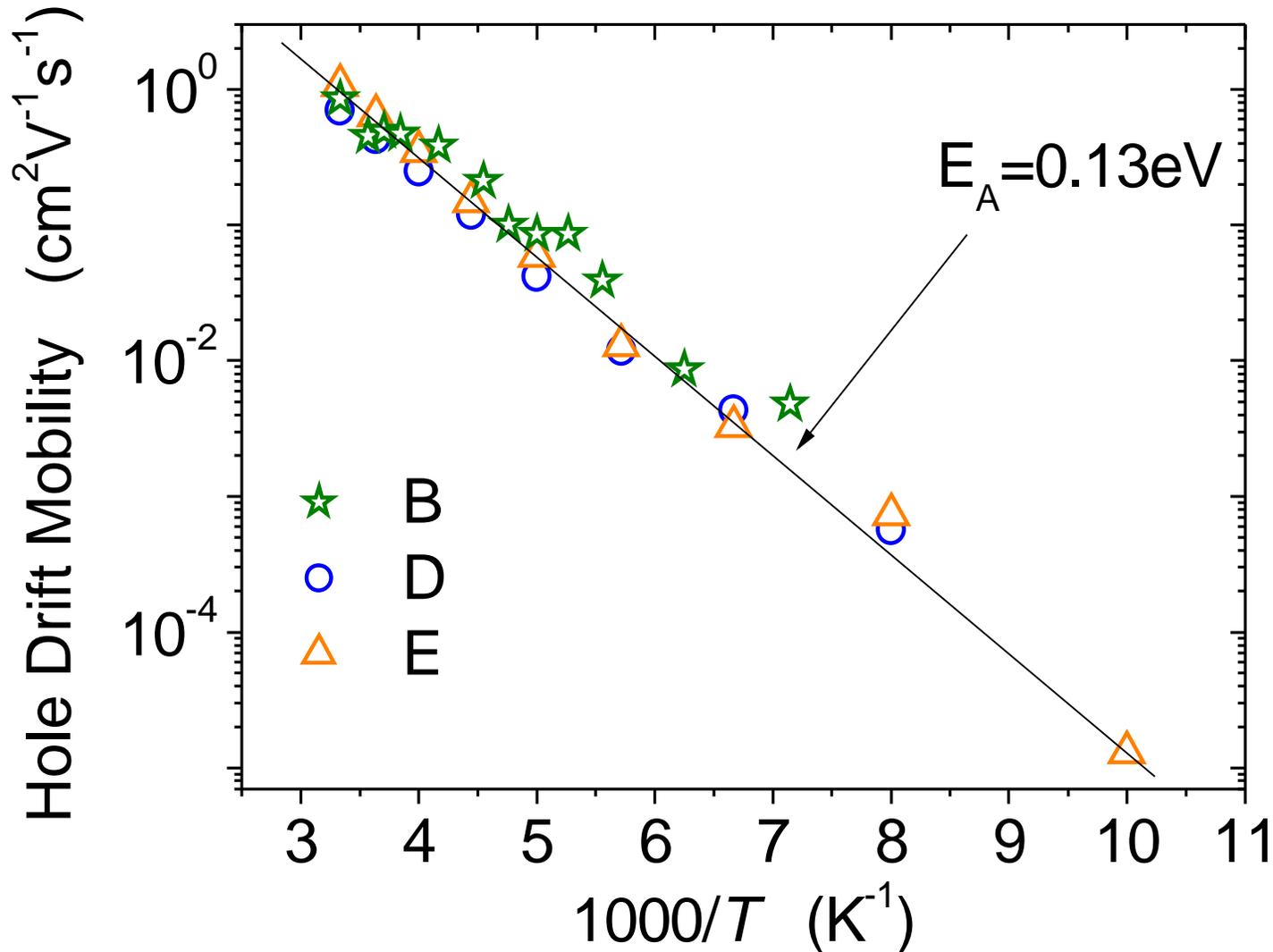


Overview of mobility effects



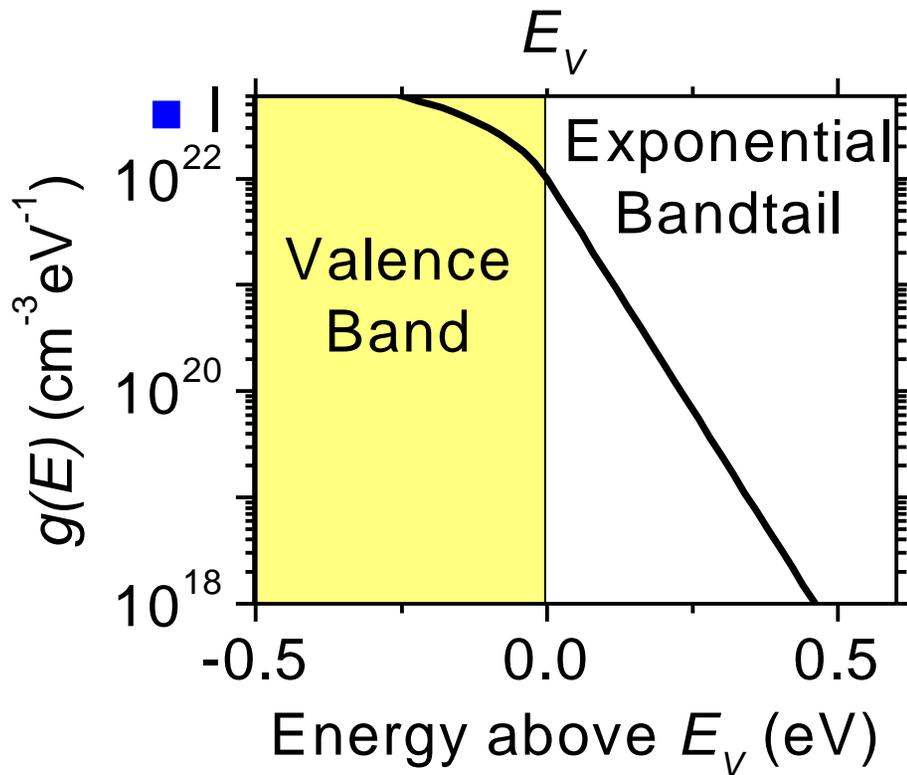


Hole Drift Mobility vs. Temperature in $\mu\text{c-Si:H}$ (FZ Jülich)





Bandtail & Multiple-Trapping Parameters

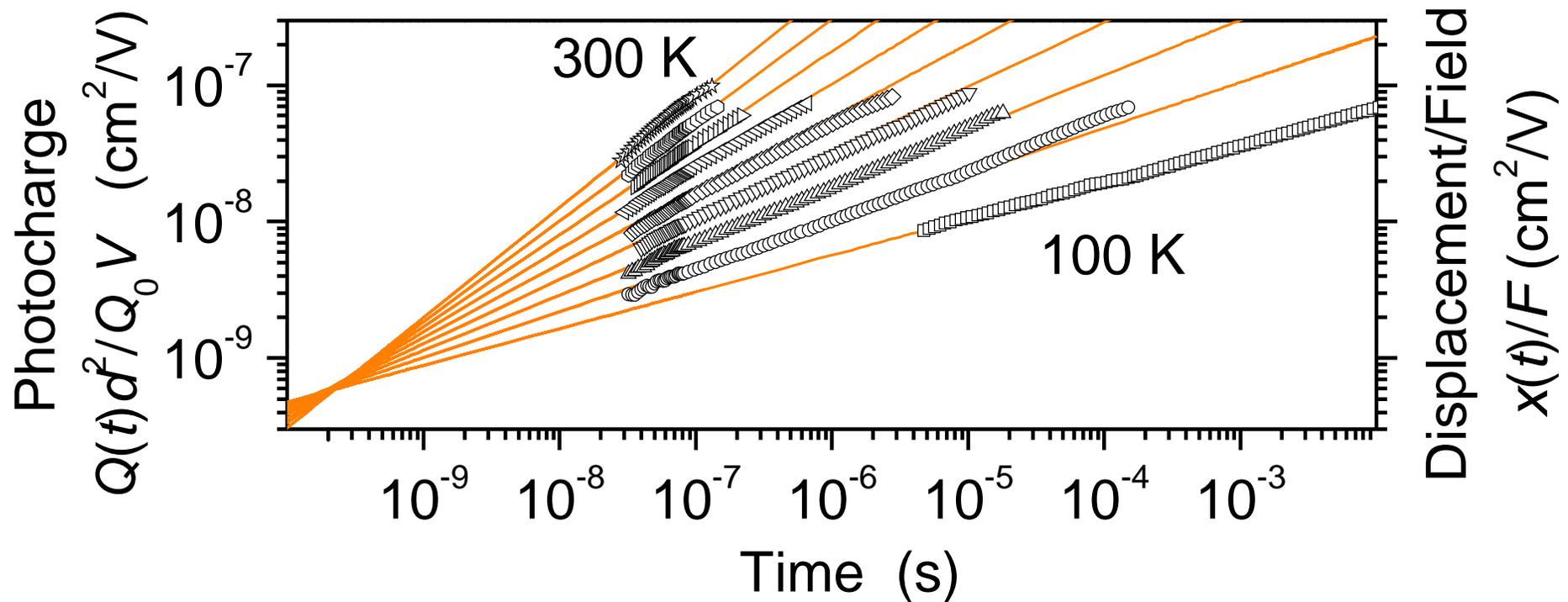


Bandtail Parameters

ΔE_V	Valence Bandtail Width
μ_h	Hole Band Mobility
ν	Attempt Frequency (= $N_V b_T$)



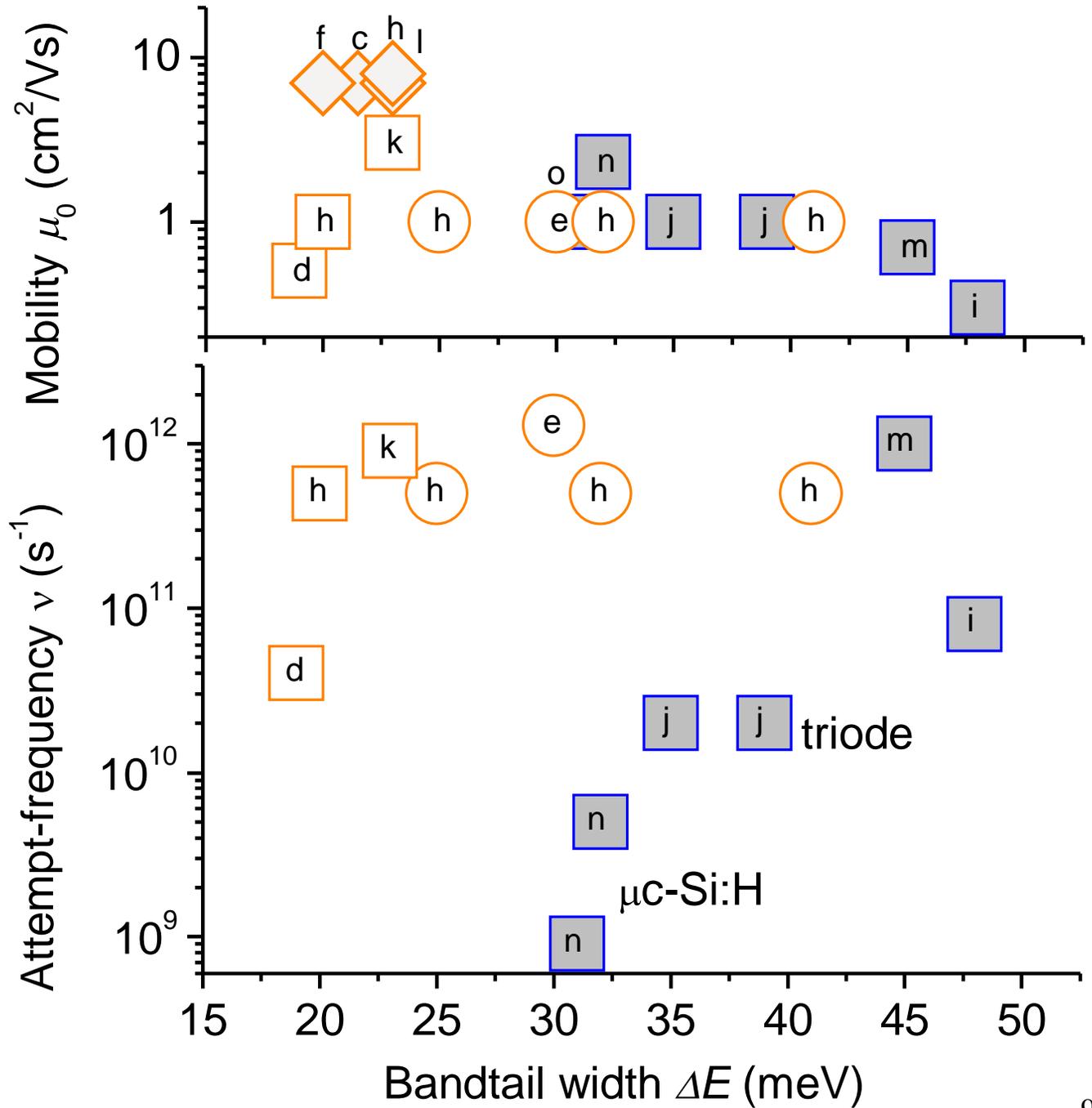
Microcrystalline Silicon: Hole Photocharge & Multiple-Trapping



Dylla, Finger, and Schiff (2005)



Exponential Bandtail Trapping: 1984-2004





Summary

- The physics of hole drift in solar-grade $\mu\text{c-Si:H}$ is consistent with valence bandtail trapping.
 - Band mobility about the same as a-Si:H
 - Bandtail width somewhat narrower (30 meV vs. 40 meV)
 - Attempt frequency much lower (10^9 s^{-1})
- Amorphous silicon solar cells are low-mobility type (slow carrier $\mu \ll 1 \text{ cm}^2/\text{Vs}$).
- Microcrystalline silicon solar cells are near the crossover between low & high mobility types (slow carrier μ about $1 \text{ cm}^2/\text{Vs}$)